

Unit 7, Part 2 Notes: From Gene to Protein

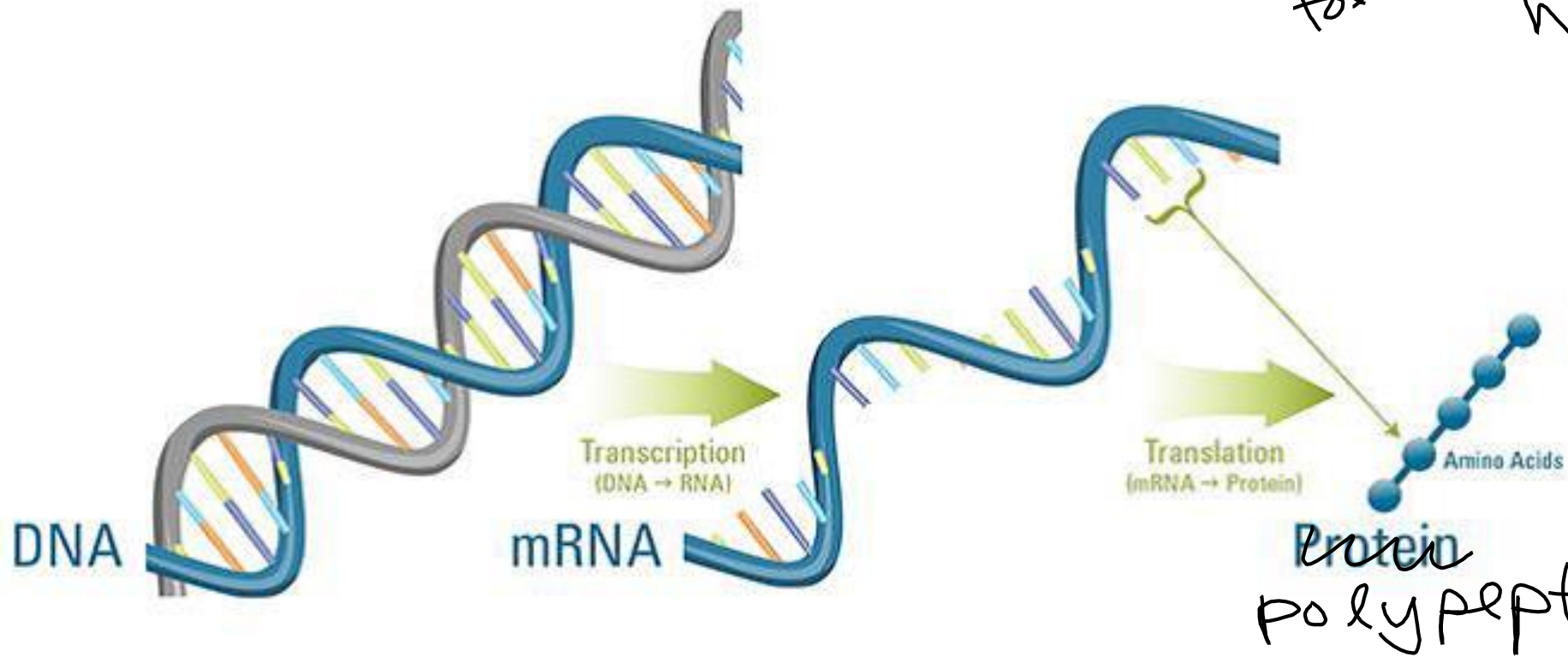
AP Biology, Mrs. Krouse

The Central Dogma of Molecular Biology

- Gene on DNA → mRNA → polypeptide
- DNA vs. RNA
- Transcription and Translation in Prokaryotic vs. Eukaryotic Cells

Gene on DNA → mRNA → polypeptide

Most full proteins consist of several polypeptides folded around each other

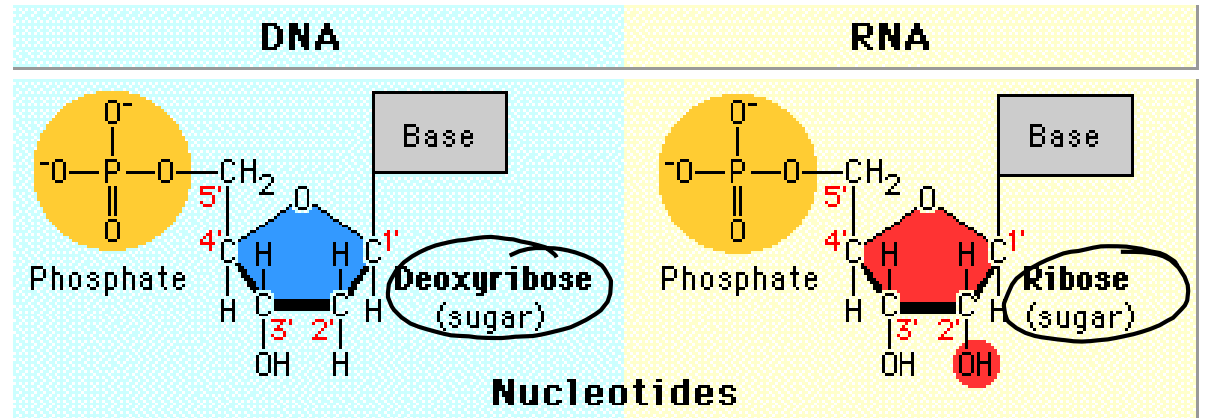


DNA vs. RNA

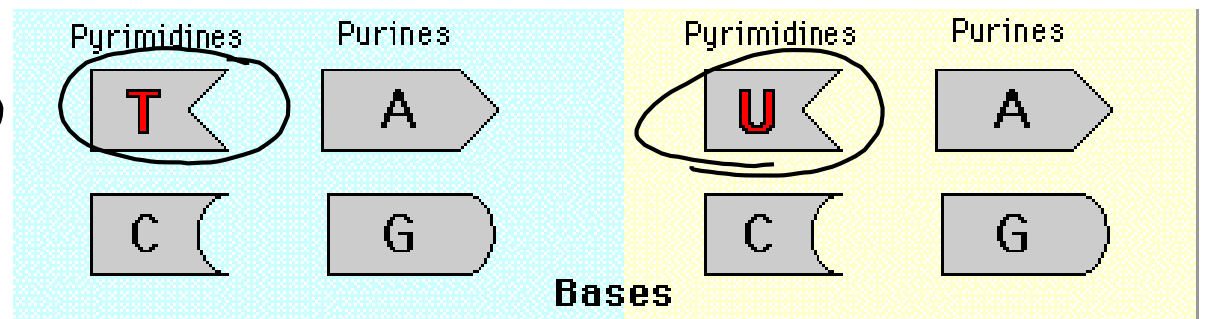
3 differences
in structure

①, ②, and ③

①

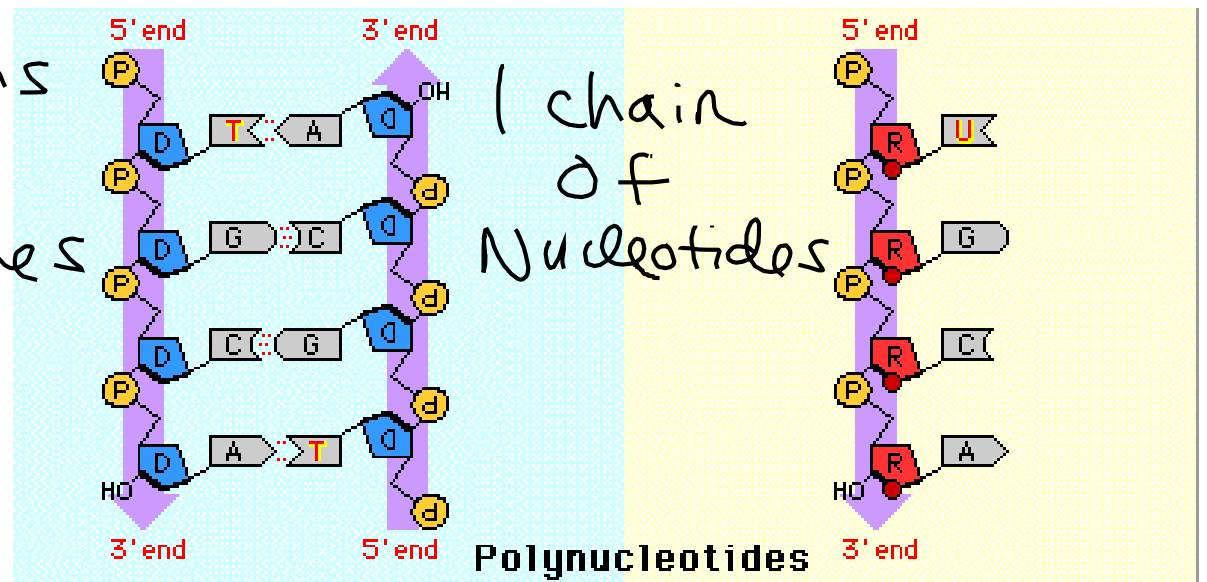


②



③

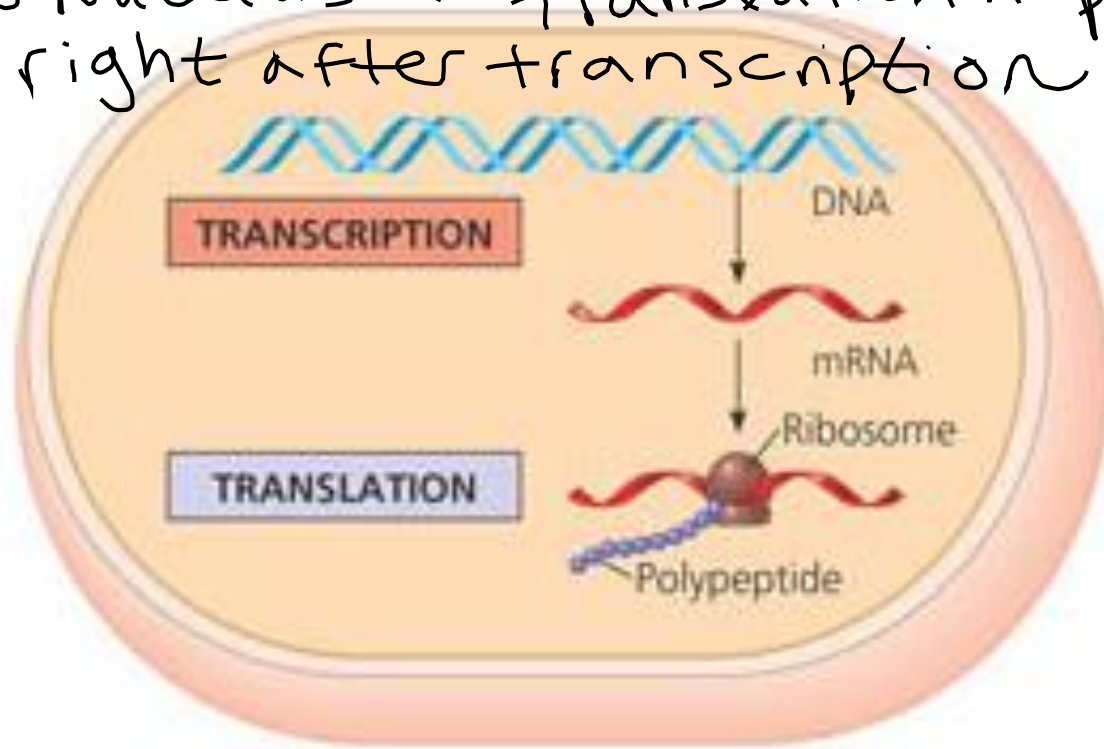
2 chains
of
Nucleotides



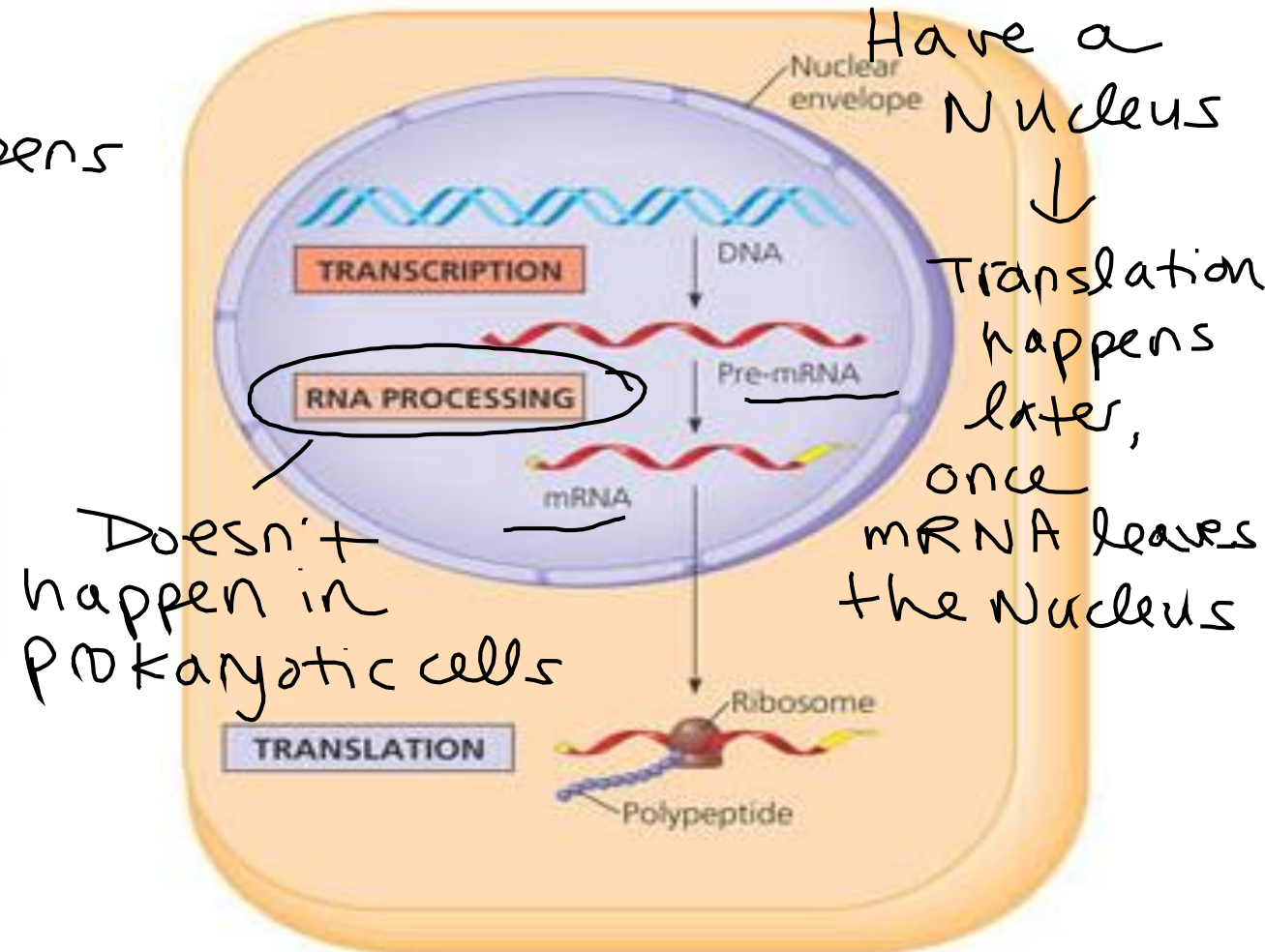
1 chain
of
Nucleotides

Transcription and Translation in Prokaryotic vs. Eukaryotic Cells

No Nucleus → translation happens right after transcription



(a) **Prokaryotic cell.** In a cell lacking a nucleus, mRNA produced by transcription is immediately translated without additional processing.



(b) **Eukaryotic cell.** The nucleus provides a separate compartment for transcription. The original RNA transcript, called pre-mRNA, is processed in various ways before leaving the nucleus as mRNA.

Types of RNA

reads the instructions on mRNA to create a polypeptide from Amino Acids

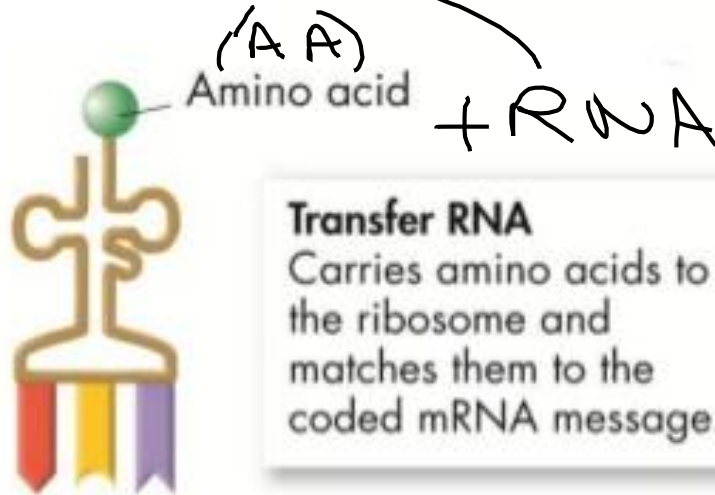
linear chain shape
mRNA = created from the DNA template strand



Messenger RNA

Carries instructions for polypeptide synthesis from nucleus to ribosomes in the cytoplasm.

3-leaf clover shape
AA



Transfer RNA

Carries amino acids to the ribosome and matches them to the coded mRNA message.

globular shape
rRNA = a component of ribosomes



Ribosome

Ribosomal RNA

Forms an important part of both subunits of the ribosome.

Transcription

3 steps of transcription
→

- Vocab Terms: (Initiation, Elongation, Termination) RNA Polymerase, Promoter, Terminator Site

- McGraw-Hill Animation: Transcription

- [Read the DNA from its 3' end, Build the RNA from its 5' end]

- Important Distinction (see image on next slide):

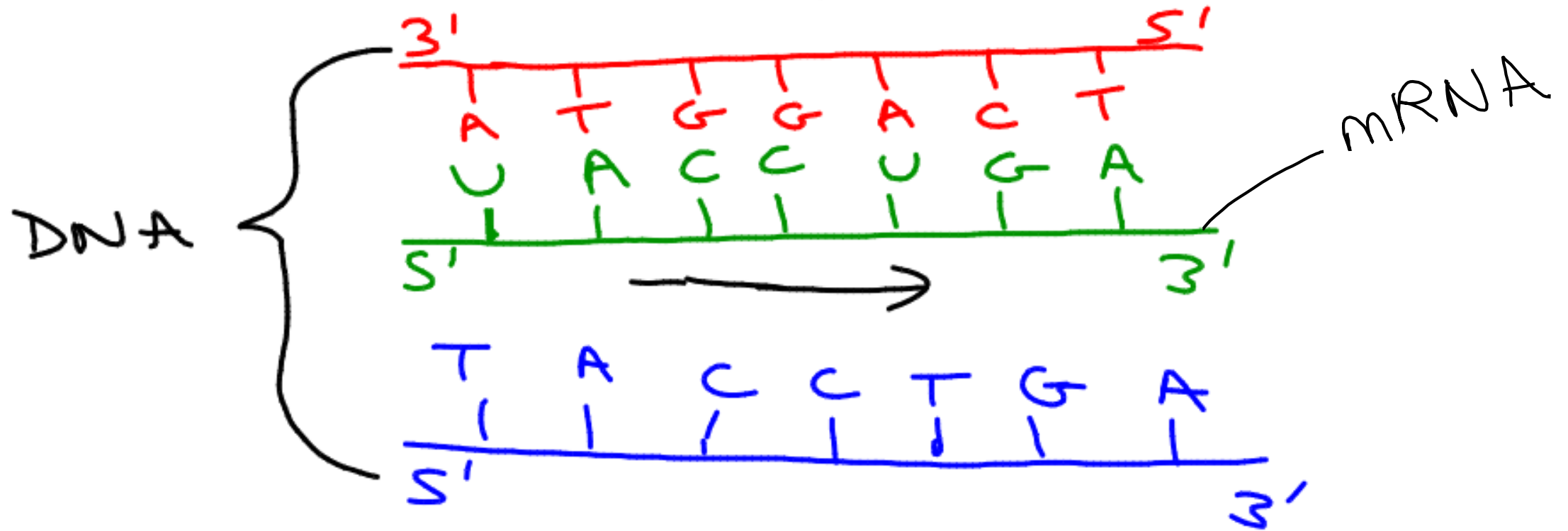
template
Strand of -Template/Noncoding/Antisense
DNA

vs.

-Non-template/Coding/Sense

[] = just like
in replication

Names for Different DNA Strands during Transcription



→ = Direction of Transcription

Red
Strand
of DNA

= Template/Noncoding/Antisense

→ because this strand
is the "model" on which
the mRNA is based

Blue
Strand
of DNA

= Non-Template/coding/sense

→ bases have the same
"code" as the mRNA
(but with T's instead
of U's)

Template,
Noncoding,
Antisense = TNCAS = Turtles Never Come
After School

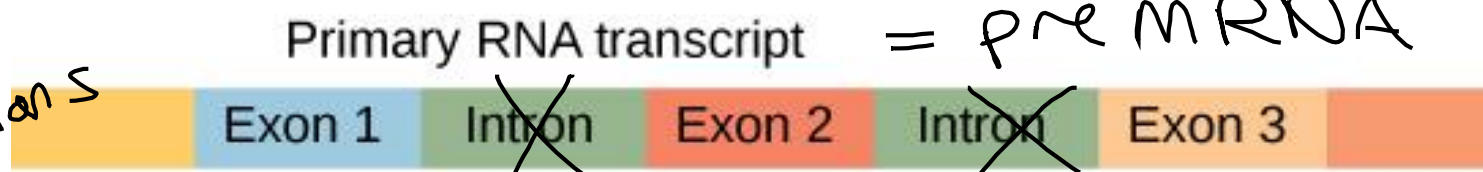
Non-Template,
Coding,
Sense = NTCS = Narwhals
Think Candy Sucks

mRNA Processing (5' cap)

- Vocab Terms: GTP cap, PolyA tail, intron, exon, small nuclear riboprotein (snRNP), spliceosome, alternative splicing, ribozyme

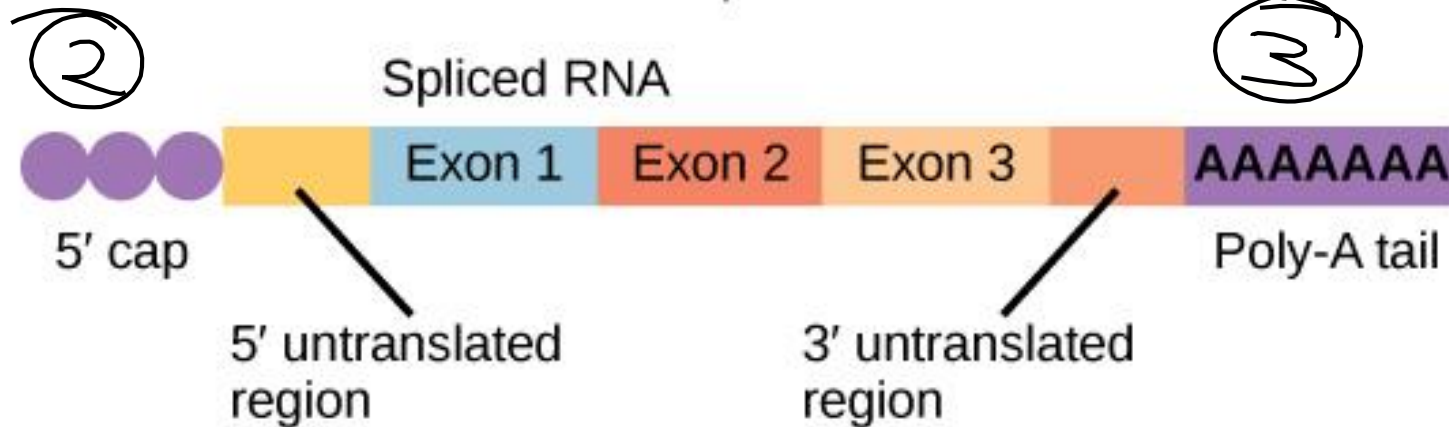
cutting out introns
(and sometimes
certain exons)

①, ②, ③ =
3 modifications
made during
mRNA
processing



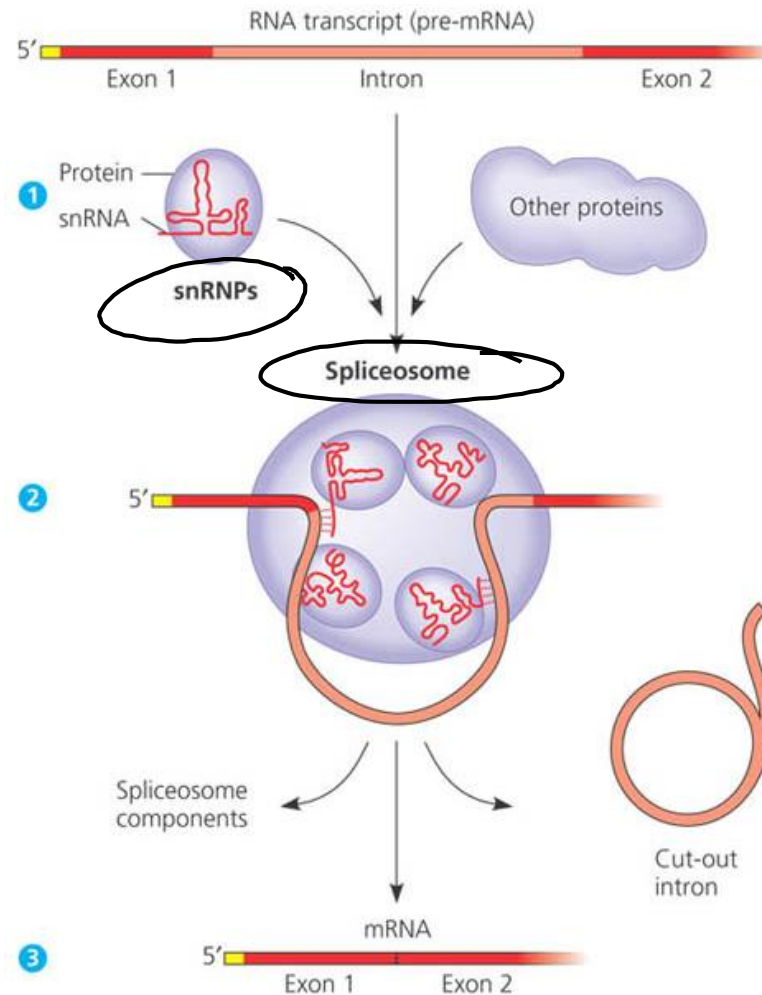
(created
directly
from DNA
during
transcription)

(mRNA)
RNA processing



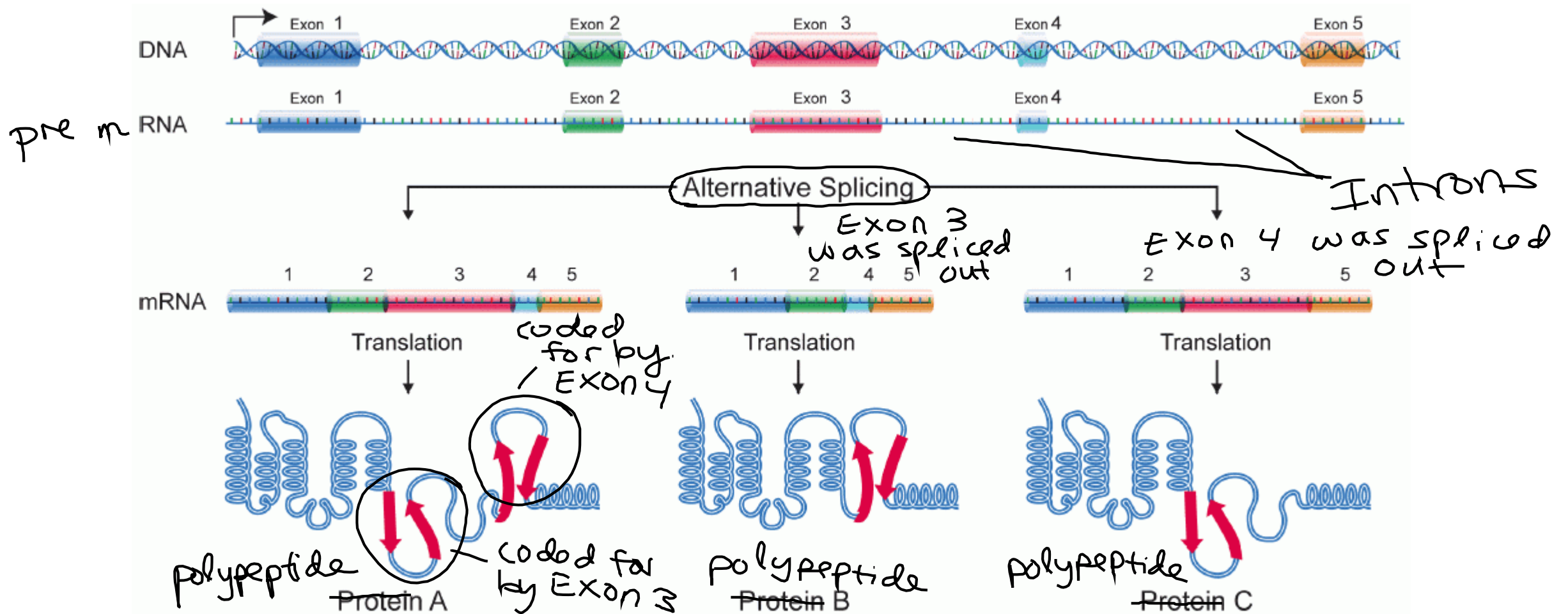
mRNA Splicing using a Spliceosome

Ribozymes =
pre mRNA
molecules that
can splice out their
own introns without
the help of
spliceosomes



Spliceosomes
are combinations
of snRNPs and
other proteins that
splice (cut) out
introns (and sometimes
certain exons)

Alternative Splicing → different exons in final mRNA → different polypeptides
→ different proteins



Alternative Splicing Animation

- [https://highered.mheducation.com/sites/9834092339/student_view0/chapter16/animation - exon shuffling.html](https://highered.mheducation.com/sites/9834092339/student_view0/chapter16/animation-exon-shuffling.html)

Stop watching when the subtitles at the bottom read “On a larger scale, it has been proposed that an advantage of gene splicing may be...”

floating in the cytoplasm
(used to make proteins that will be used inside the cell)

Translation

on Rough ER (used to make secretory proteins, which leave the cell and are used to communicate with other cells)

- Vocab: Ribosome (large and small subunits), attached/bound ribosomes, free/unbound ribosomes, [A site, P site, E site] (initiation, elongation, termination), codon, start codon, stop codon, anticodon, peptide bond, amino acid, polysomes

[] = locations in ribosome where tRNA molecules can bind to mRNA

() = Three steps of translation

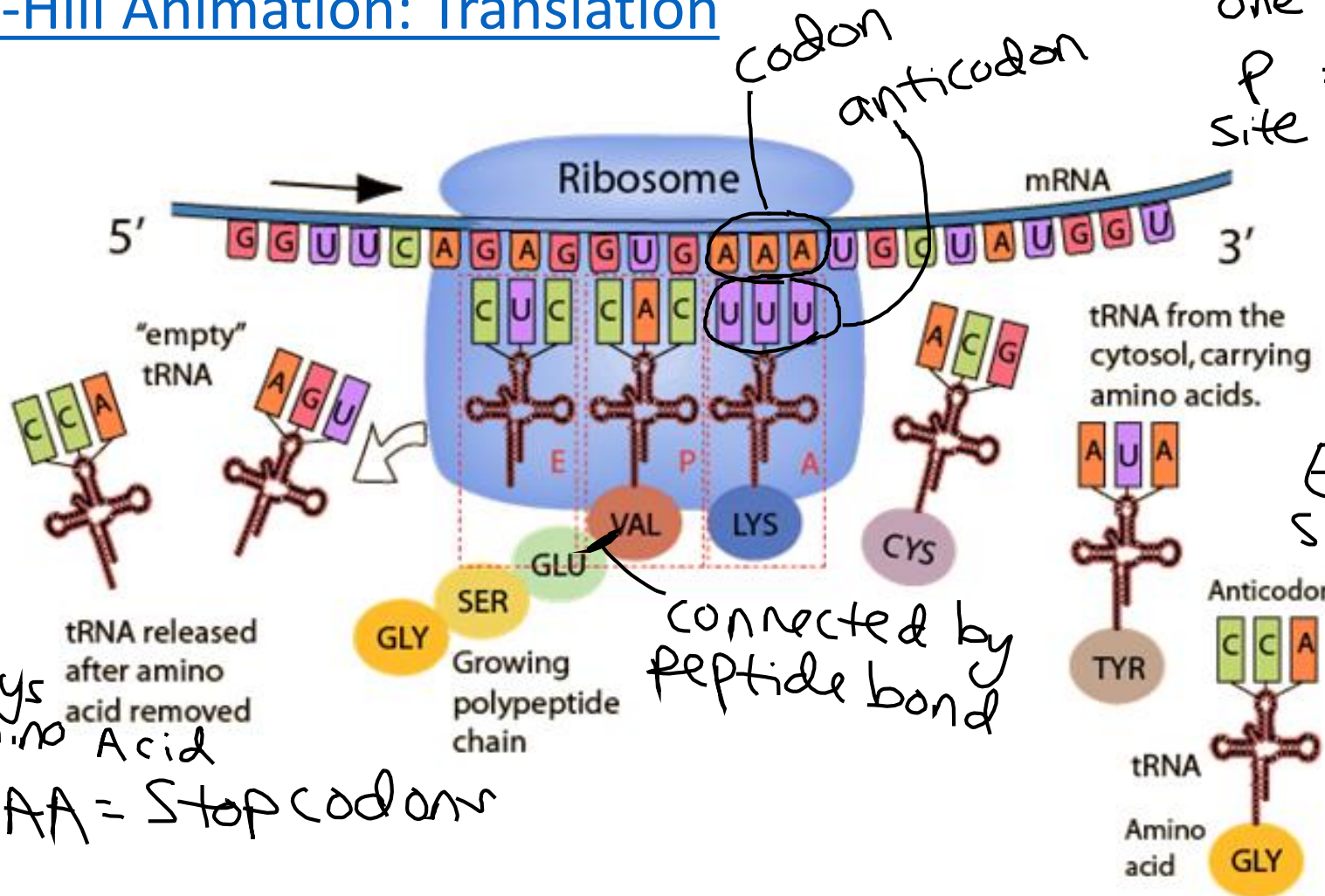
Translation

- [McGraw-Hill Animation: Translation](#)

Read the mRNA from its 5' to 3' end

AUG = start codon
 ↳ "Met" is always the first amino acid

UAG, UGA, UAA = Stop codons



A = "All Aboard" site where all tRNAs other than the first one enter the ribosome

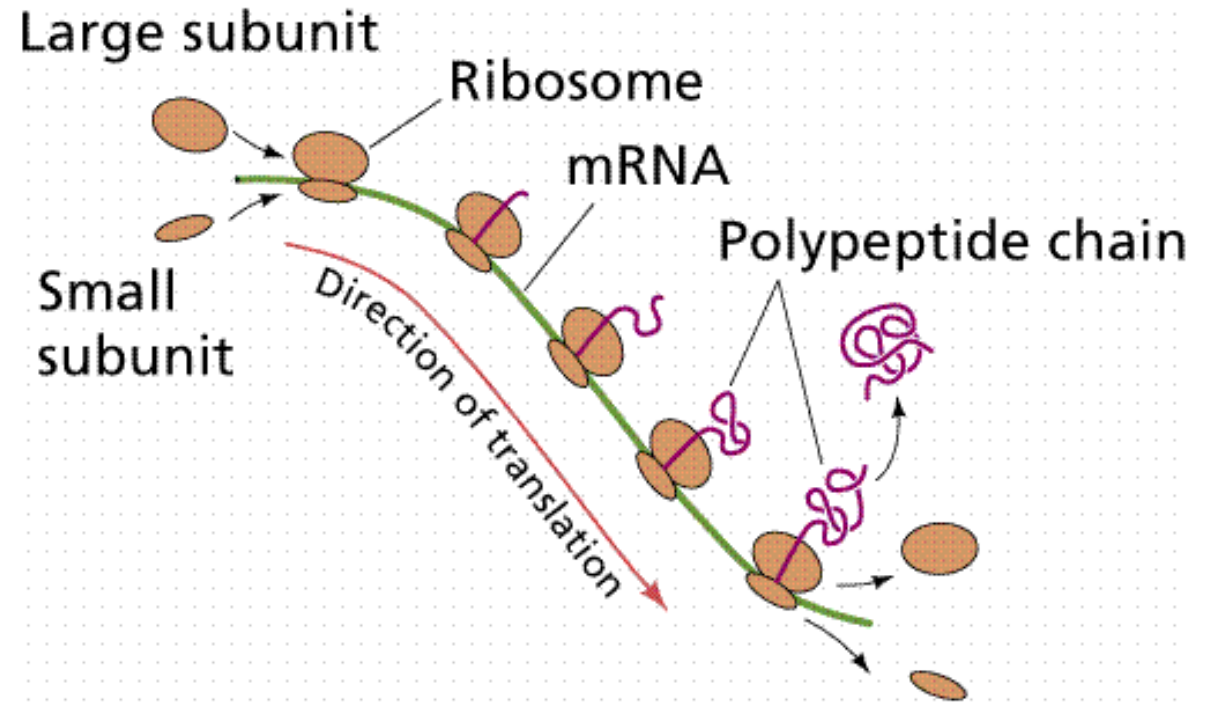
P = in the middle, site receive tRNAs from the A site, first tRNA skips the A site and enters the P site first

E = "Exit" site where naked tRNAs that have lost their amino acid exit the ribosome

connected by peptide bond

Polysomes

- Multiple ribosomes translating an mRNA molecule at the same time.... First ribosome starts at the 5' end of the mRNA and moves towards the 3' end, leaving the 5' end available for another ribosome to begin
- Results in more efficient translation → more polypeptides created in a given amount of time from the same mRNA



Codon Chart

3 bases on mRNA → Amino Acid

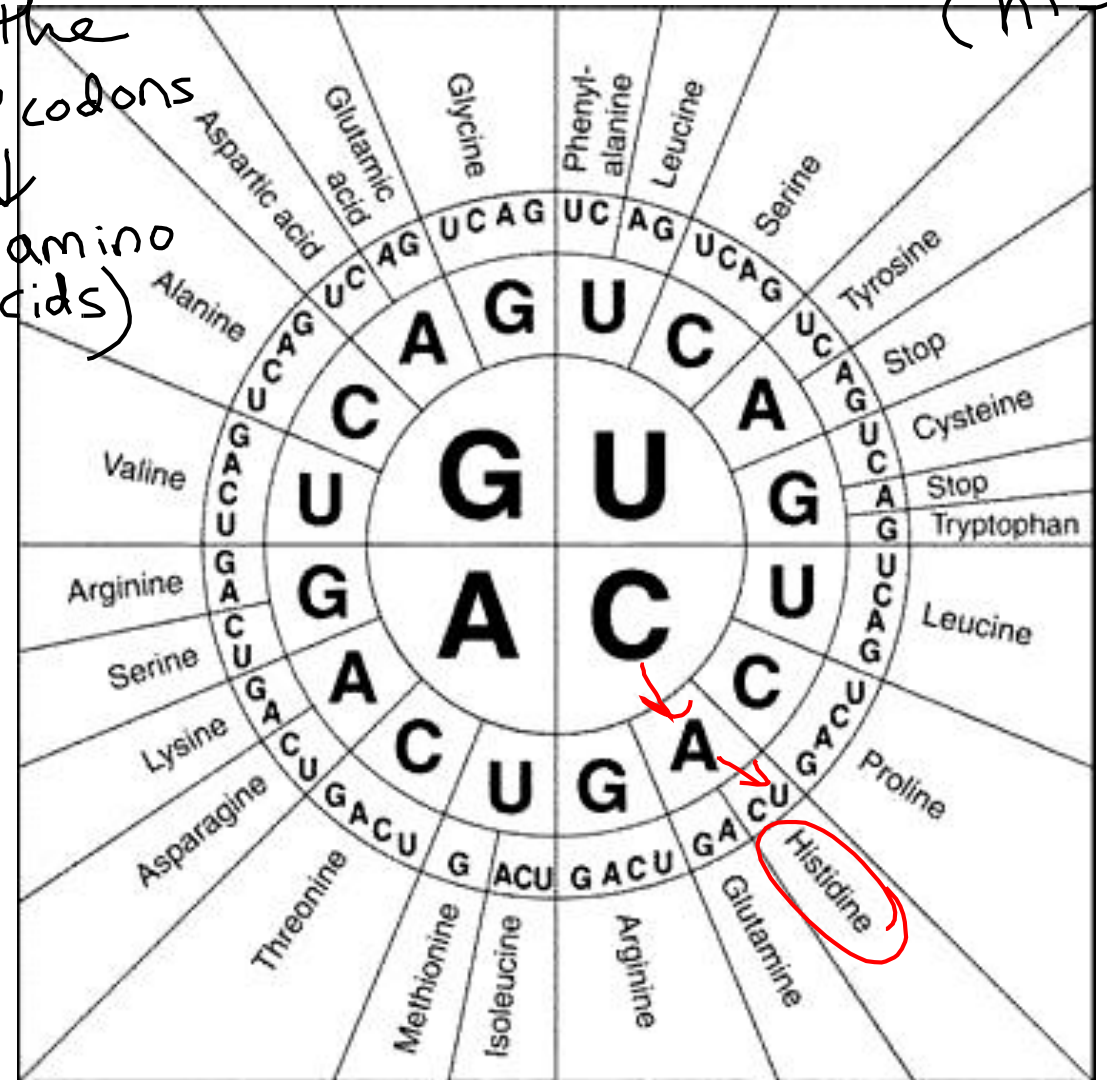
Example codon:
CAU → histidine (his)

changing the 3rd base doesn't always change the Amino Acid

3rd Base Wobble → Redundancy in the genetic code (64 codons)

20 amino acids

First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	(start) methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

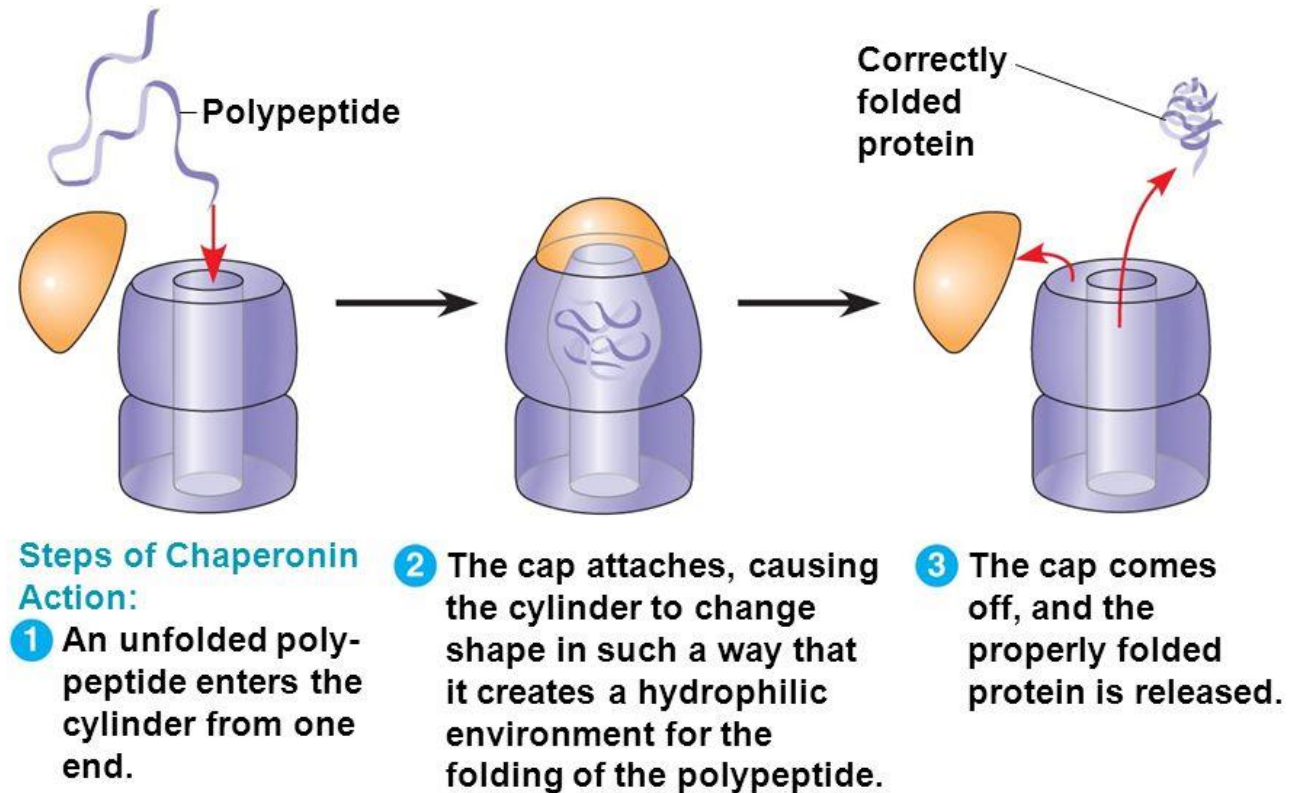


Post-Translational Modifications

LE 5-23b

- Chaperonins

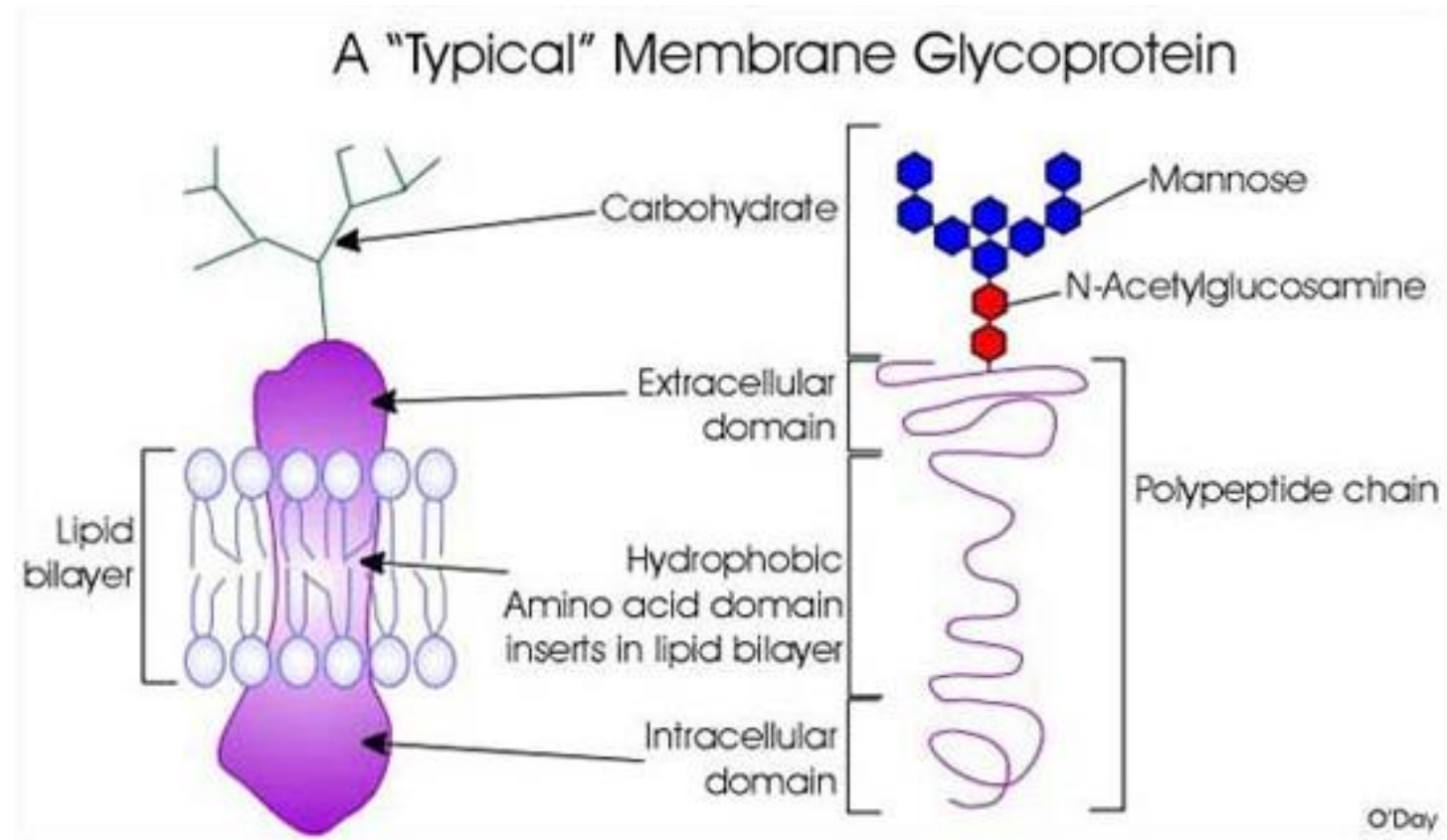
barrel-shaped proteins in which one polypeptide or multiple polypeptides fold to create the final protein
(protein shape → function)



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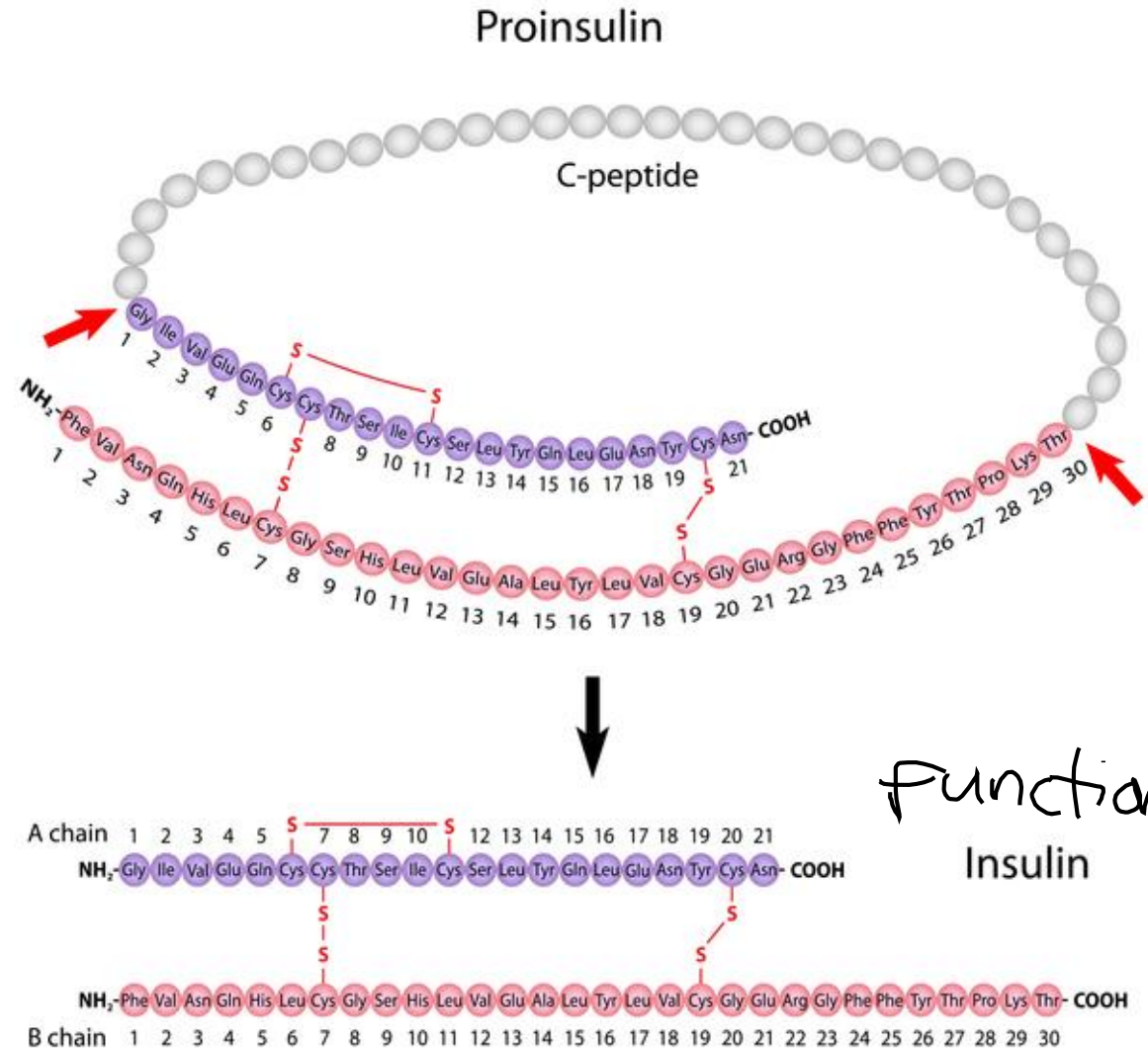
Post-Translational Modifications

- Adding molecular groups (ex: adding a carbohydrate chain to a protein to create a glycoprotein, which is used to help cells recognize each other)

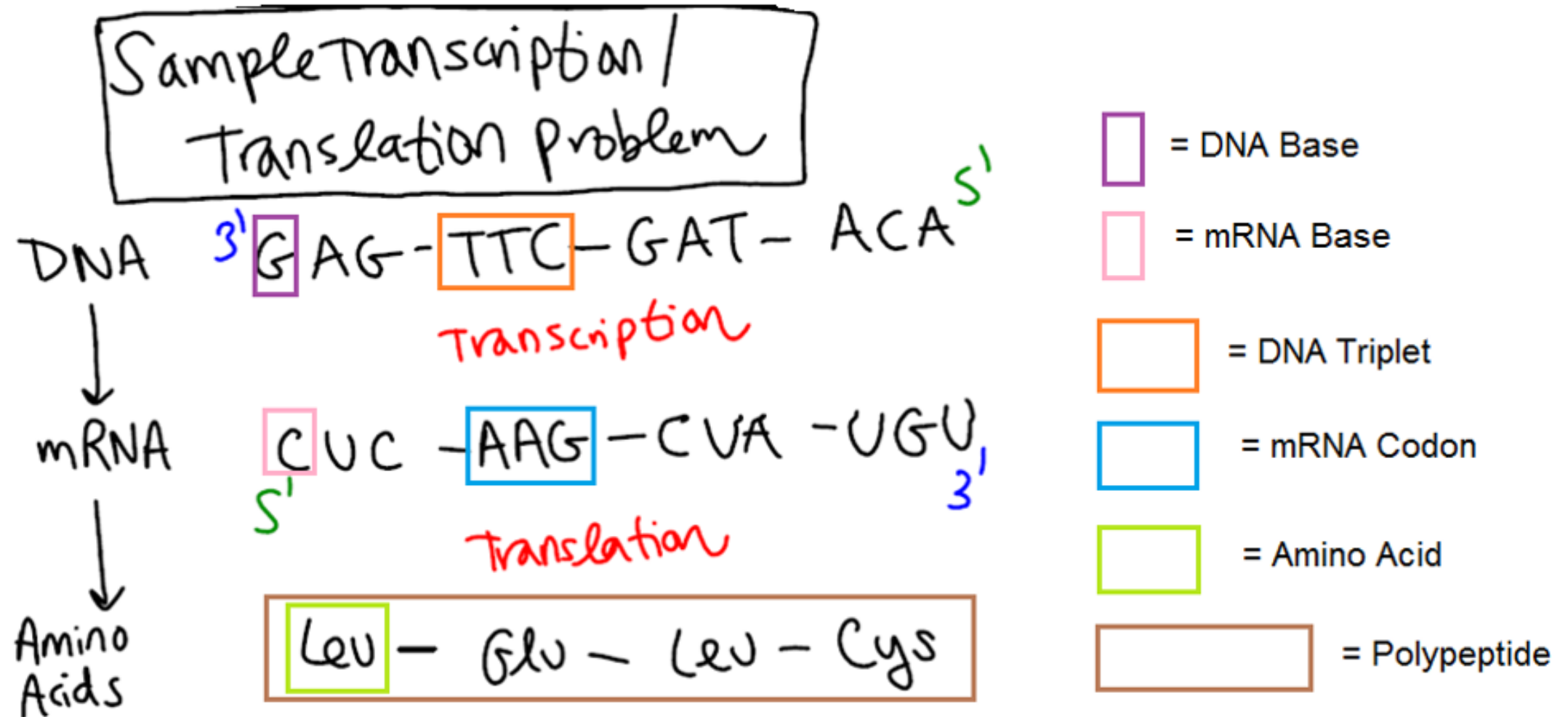


Post Translational Modifications

- Removal of amino acids from pro-insulin to create insulin



Vocabulary Clarification



Direction of DNA Replication, Transcription and Translation Clarification

Read the **PD** from its 3', Build the **ND** from its 5'
parent / template DNA new / daughter DNA

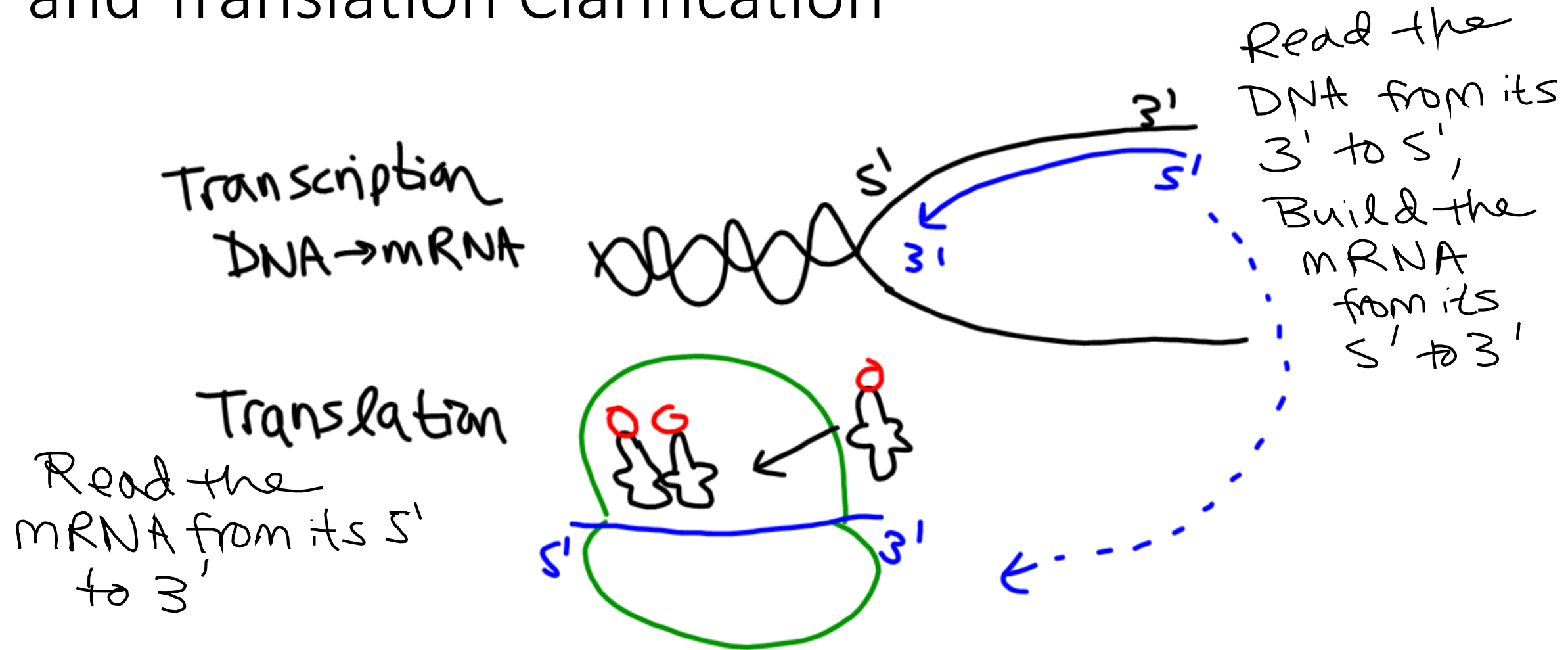
DNA
Replication



Leading strand = built into the replication fork
in one piece (continuously)

Lagging strand = built out of the fork in chunks

Direction of DNA Replication, Transcription and Translation Clarification

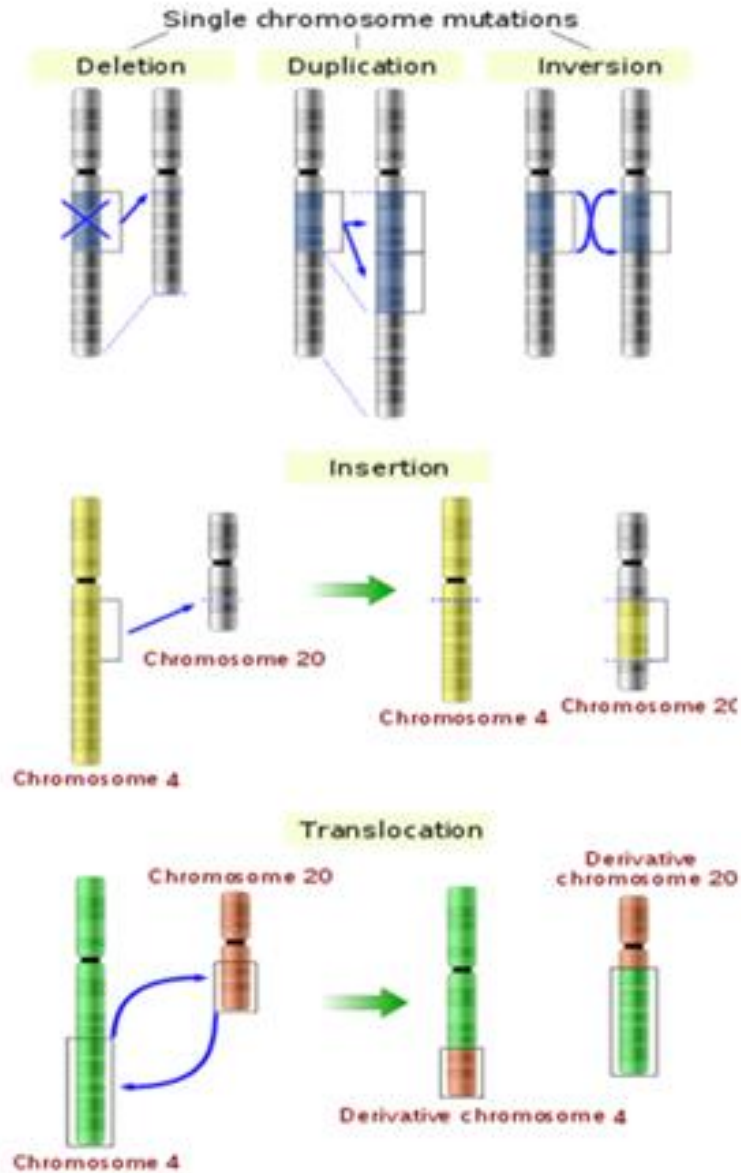


Errors in the DNA, RNA, and Protein Sequence

- Vocab Terms: Mutation, mutagen, carcinogen
- Major Chromosomal Mutations: Duplication, inversion, insertion, deletion (add this one)
- Base Change / Gene Mutations:
 - Point Mutation (aka substitution): silent, missense, nonsense
 - Frameshift Mutation: insertion, deletion

Major Chromosomal Mutations

Major Chromosomal Mutations



Point Mutation

Normal DNA	AAA - GGG - TTT - CCC
mRNA	UUU - CCC - AAA - GGG
Amino Acids	phe - pro - Lys - Gly
<hr/>	
mutated DNA #1	AAA - <u>T</u> GG - TTT - CCC
mRNA	UUU - <u>A</u> CC - AAA - GGG
Amino Acids	phe - <u>Thr</u> - Lys - Gly

Type of Mutation: point mutation - Missense
(substitution)

Frameshift Mutation

Normal DNA	AAA - GGG - TTT - CCC
mRNA	UUU - CCC - AAA - GGG
Amino Acids	phe - pro - Lys - Gly

Mutated DNA	AAA - C GG - GTT - TCC - C
#2 mRNA	UUU - G CC - CAA - AGG - G
Amino Acids	phe - <u>Ala - Glu - Arg</u>

Type of Mutation: Frameshift-Insertion